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# Mindful eating and change in depressive symptoms: Mediation by psychological eating styles

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## ABSTRACT

Earlier cross-sectional research showed that a higher level of mindful eating is associated with less depression. This study investigated associations of attentive mindful eating with change in depressive symptoms, as well as mediation by psychological eating styles, in the Longitudinal Aging Study Amsterdam ( $n = 946$ ). The mindful eating domains Focused Eating, Eating in response to Hunger and Satiety Cues, Eating with Awareness and Eating without Distraction were measured by the Mindful Eating Behavior Scale. Three-year change in depressive symptoms was measured with the Center for Epidemiologic Studies Depression Scale. Emotional, external and restrained eating were measured by the 20-item version of the Dutch Eating Behaviour Questionnaire. Higher baseline scores on Focused Eating, Eating with Awareness and Eating without Distraction were associated with a 3-year decrease in depressive symptoms. Eating in response to Hunger and Satiety Cues was not associated with a change in depressive symptoms. Multiple mediation models showed mediation by external eating for the domains Eating with Awareness, Eating without Distraction, and Eating in response to Hunger and Satiety Cues, but no mediation by emotional and restrained eating. No mediation by the eating styles was found for Focused Eating. In this study, higher scores on three mindful eating domains were associated with a decrease in depressive symptoms. Mediation analyses suggest that three domains are associated with depression through external eating.

## 1. Introduction

Depression is a highly prevalent mental disorder with a high burden of disease (WHO, 2017). A higher level of mindfulness—“an enhanced attention to and awareness of current experience or present reality” (Brown & Ryan, 2003)—is related to a decrease in depressive symptoms in clinical (Hofmann, Sawyer, Witt, & Oh, 2010; Keng, Smoski, & Robins, 2011) and non-clinical samples (Klainin-Yobas, Cho, & Creedy, 2012). In a previous study, higher scores on three domains of a newly developed mindful eating scale (Winkens, van Strien, Barrada, Brouwer, Penninx, & Visser, 2018)—Focused Eating, Eating with Attention and Eating without Distraction—were associated with less depression in three European samples (Winkens, van Strien, Brouwer, Penninx, Visser, & Läähteenmäki, 2018). Since lack of interest is one of the core symptoms of depression, paying attention to and having interest in eating behaviour might be related to less depressive symptoms over time. There is, however, no current published research into associations

between mindful eating and changes in depressive symptoms. Furthermore, underlying mechanisms in these associations are to the best of our knowledge not investigated yet.

### 1.1. Psychological eating styles

From a theoretical perspective, three psychological eating styles—emotional, external and restrained eating—are possible underlying mechanisms in the associations between mindful eating and depression. Emotional eating is eating in response to negative emotions (van Strien, Donker, & Ouwens, 2016), which is an atypical stress response (Heatherton, Herman, & Polivy, 1991). Emotional eating occurs when people give the emotion more attention than their hunger signals, because they have difficulties in distinguishing hunger from other states of bodily arousal (Van Strien & Ouwens, 2003), or because they learned to eat in response to emotions in order to reduce emotional distress (Heatherton et al., 1991). External eating is eating in response to food

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stimuli such as sight, smell and taste of attractive food regardless of internal feelings of hunger and satiety (Schachter, Goldman, & Gordon, 1968). Restrained eating involves restriction of food intake or dieting and requires checking food intake against dieting rules instead of hunger and satiety signals (Stroebe, Van Koningsbruggen, Papies, & Aarts, 2013). Restrained eating is linked to positive outcomes such as effective weight management, as well as to negative outcomes such as increased eating pathology risk. This outcome is based on the ability to employ self-regulatory strategies (Schauberg, Anderson, Anderson, Reilly, & Gorrell, 2016). Emotional, external, and restrained eaters do not rely on physical hunger and satiety cues to guide their eating behaviour.

### 1.2. Mindful eating and psychological eating styles

Mindfulness is associated with less behavioural automaticity and increased self-regulation towards eating behaviours (Wolever & Best, 2009), which may contribute to less overeating and fewer maladaptive eating behaviours (Brown & Ryan, 2003; Levesque & Brown, 2007). Two literature reviews showed that most mindfulness-based interventions focused on lowering emotional and external eating resulted in reductions in emotional and external eating (Warren, Smith, & Ashwell, 2017; O'Reilly, Cook, Spruijt-Metz, & Black, 2014). Compared to general mindfulness interventions, interventions with a mindful eating component were most effective in achieving these changes (O'Reilly et al., 2014). Contrary to expectations, higher observing, which is noticing more or attending more to stimuli, predicted higher emotional and external eating scores across 6 months (Sala & Levinson, 2017). Mindfulness-based eating interventions led to increased restrained eating scores (Alberts, Thewissen, & Raes, 2012; Dalen et al., 2010). Empirically, studies thus show associations between mindful eating and eating styles, although most study samples are small and predominantly female, and findings are not consistent. The current study can provide more clarity regarding the mixed previous results by using a large representative sample of older adults and by making use of a mindful eating scale that can measure mindful eating distinguishable from the eating styles (Winkens, van Strien, Barrada et al., 2018).

### 1.3. Psychological eating styles and depressive symptoms

Eating styles have been associated with depression. Different studies found that more emotional eating was associated with higher depressive symptoms (Goldschmidt et al., 2014; Konttinen, Silventoinen, Sarlio-Lähteenkorva, Männistö, & Haukka, 2010; Ouwers, van Strien, & van Leeuwe, 2009), depression and longer symptom duration (Paans et al., 2018), depression history (Paans et al., 2018), and depression severity (Paans et al., 2018; Paans et al., 2018). More external eating was associated with depression and longer symptom duration (Paans et al., 2018). More restrained eating was found to predict the onset of incident major depression in female adolescents (Stice, Hayward, Cameron, Killen, & Taylor, 2000), while it was related to lower depressive symptoms in women with subsyndromal depression (Paans et al., 2018), and was not related to current or remitted depression (Paans et al., 2018).

### 1.4. Research questions and hypotheses

Whether the mindful eating domains are associated with change in depressive symptoms and whether eating styles mediate these associations is currently unclear. Hence, the aims of this study were to test 1) whether there are associations of the mindful eating domains with change in depressive symptoms over three years and, 2) whether the eating styles act as potential mediators of these associations. Based on earlier cross-sectional results, we expected associations between mindful eating and change in depressive symptoms in that higher mindful eating scores are associated with lower depressive symptoms

scores. We also expected emotional and external eating to be mediators, so that higher mindful eating scores are related to lower emotional and external eating scores, which subsequently are related to lower depressive symptom scores. For restrained eating the analyses were exploratory, because earlier results were mixed.

## 2. Methods

### 2.1. Participants and procedure

Data were collected within the Longitudinal Aging Study Amsterdam (LASA), an ongoing cohort study in a representative sample of Dutch older adults aged 55 years and over, which started in 1992. The sampling and data collection procedures have been described in detail elsewhere (Hoogendijk et al., 2016; Huisman et al., 2011). Ethical approval for the LASA study was given by the Medical Ethics Committee of the VU University Medical Center Amsterdam and all participants provided written informed consent.

Depressive symptoms and antidepressant use were measured in the 3-yearly measurement waves of LASA. For our study, baseline depressive symptoms and antidepressant use were measured in either 2011–2012 (cohort 1 and 2) or 2012–2013 (cohort 3). Follow-up data on depressive symptoms and antidepressant use was collected in 2015–2016 in all three cohorts. Mindful eating and the psychological eating styles were measured in the 'LASA Nutrition and Food-related Behaviour ancillary study' that was conducted between the fall of 2014 and the spring of 2015 (for details, see Winkens, van Strien, Barrada, et al., 2018). By using the depressive symptoms score at the follow-up measurement as outcome variable and adjusting analyses for baseline depressive symptoms, the outcome was interpreted as 'change in depressive symptoms'. However, it should be noted that mindful eating and the eating styles were measured in-between this follow-up period thereby making strict longitudinal interpretation of associations impossible.

## 3. Measures

### 3.1. Depressive symptoms and antidepressant use

The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) was used to measure depressive symptoms in the past week and was administered in face-to-face interviews. The scale has 20 items with a 4-point scale ranging from 0 (rarely or none of the time; less than one day) to 3 (most or almost all the time; 5–7 days). A higher score indicates a higher level of depressive symptoms. Cronbach's alpha of the CES-D were 0.87 (cohort 1 and 2;  $n = 501$ ) and 0.85 (cohort 3;  $n = 445$ ) at baseline, and 0.85 at the follow-up measurement.

People with antidepressant use at baseline and/or the follow-up measurement were excluded from all analyses. Data on antidepressant use were retrieved by asking about medicine use. Medication names were recoded into Anatomical Therapeutic Chemical codes, which were used to define the use of antidepressants (yes/no; WHO, 2018).

### 3.2. Mindful eating domains

The Mindful Eating Behavior Scale (MEBS; Winkens, van Strien, Barrada, et al., 2018) was used to measure the level of four domains of the attention element of mindful eating: Focused Eating (5 items, e.g. 'I notice how my food looks'); Eating with Awareness (3 items, e.g. 'I eat something without being really aware of it', reversed item); Eating in response to Hunger and Satiety Cues (5 items, e.g. 'I trust my body to tell me when to eat'); and Eating without Distraction (4 items, e.g. 'I multi-task when I am eating', reversed item). Answer options ranged from 1 'never' to 5 'very often'. Higher scores indicate a higher level of mindful eating. Cronbach's alpha of the mindful eating domains were 0.84 for Focused Eating, 0.90 for Eating in response to Hunger and

Satiety Cues, 0.82 for Eating with Awareness, and 0.71 for Eating without Distraction.

### 3.3. Psychological eating styles

Three psychological eating styles (emotional eating, external eating and restrained eating) were measured with the 20-item version of the Dutch Eating Behaviour Questionnaire (DEBQ-20; van Strien et al., 2016; Paans et al., 2018), which is the brief version of the original 33-item DEBQ (van Strien, Frijters, Bergers, & Defares, 1986). Emotional eating was measured with 6 items, and external eating and restrained eating both with 7 items. Answer options ranged from 1 ‘never’ to 5 ‘very often’. Mean scores were calculated, ranging from 1 to 5. Higher scores indicate higher levels of those eating styles. Cronbach's alpha of the eating styles were 0.93 for emotional eating, 0.77 for external eating, and 0.86 for restrained eating.

### 3.4. Confounders

Confounders were sex, age, educational level, alcohol consumption, smoking status, physical activity level and body mass index because demographic and lifestyle factors have shown to be related to both eating behaviour and depression and might therefore bias the associations under study. These variables were measured at the baseline measurement (2011–2013).

Sex and age were derived from the municipal registries.

Educational level was self-reported and categorized into low (none, elementary school), medium (secondary education, lower and intermediate vocational training) and high (higher vocational training, college and university education).

Alcohol consumption was assessed by asking respondents about the number of days per week they drank alcohol and the number of alcoholic drinks on these days (Central Bureau of Statistics, 1989). The number of alcoholic consumptions per week was calculated.

Smoking status (never-former-current) was self-reported.

Physical activity was measured using the validated LASA Physical Activity Questionnaire (LAPAQ; Stel et al., 2004). Frequency and duration of walking outdoors, bicycling, light and heavy household activities and two sports in the past two weeks were asked. Total time in minutes per day spent on these activities was calculated.

Body mass index (BMI) in kg/m<sup>2</sup> was calculated by dividing measured body weight (kg) by measured body height squared (m). Body weight was measured to the nearest 0.1 kg using a calibrated bathroom scale (Seca, model 100, Lameris, Utrecht, The Netherlands). Corrections were made to adjust the measured body weight for clothing, shoes or a corset (minus 1 kg for one of those elements and minus 2 kg for more than one) when people did not wear underclothing only (30.1% of sample). Body height was measured to the nearest 0.001 m using a stadiometer. Corrections were made to adjust the measured height for shoes (minus 1 cm) when people did not take off their shoes (0.3% of sample).

### 3.5. Statistical analysis

All analyses were conducted using SPSS 23 (IBM Corporation, 2013). People were included who had data on depressive symptoms at both the baseline and follow-up measurement. People that did not fill out the questionnaire of the ‘LASA Nutrition and Food-related Behaviour study’ themselves, or who had missing values on one of more of the used variables, were excluded from the analyses. People with antidepressant use at baseline and/or follow-up measurement were excluded because of possible distortion of the CES-D scores. All analyses were adjusted for baseline depressive symptoms so that the outcome could be interpreted as ‘change in depressive symptoms’. To test whether the associations were independent from demographic and lifestyle variables, analyses were additionally adjusted for baseline sex, age,

educational level, alcohol consumption, smoking status, physical activity level and BMI.

First, a characterisation of the sample was given using descriptive statistics.

To test whether the mindful eating domains were associated with change in depressive symptoms, associations between each mindful eating domain and depressive symptoms at follow-up after adjustment for baseline depressive symptoms were tested by using linear regression analyses. Because the CES-D scores were skewed to the right, bias-corrected and accelerated (BCa) bootstrap confidence intervals (CI) were computed, which correct for bias and skewness in the distribution of bootstrap estimates (Efron, 1987).

To test whether the psychological eating styles were mediators in the association of each mindful eating domain with change in depressive symptoms, the psychological eating styles were tested as mediating variables in multiple mediation models. By testing multiple mediators in one model compared to simple mediation models, the likelihood of parameter bias due to omitted variables is reduced (Preacher & Hayes, 2008). A significant total indirect effect is no prerequisite for investigating specific indirect effects; either or both types of effect are interesting and worth investigating (Preacher & Hayes, 2008). Therefore, both the total indirect effect of the set of mediators as well as the specific indirect effects of the individual mediators conditional on other mediators in the model were reported, together with the corresponding bias-corrected (BC) 95% CIs. It is important to note that the specific indirect effects through the eating styles represent the ability of that eating style to mediate the association of mindful eating with depressive symptoms conditional on the inclusion of the other eating styles in the model: it is thus the unique mediating effect of that eating style.

The multiple mediation models were tested for the different mindful eating domains separately with the Process macro of Hayes (Hayes, 2013). Bootstrapping with 5000 samples was used in all analyses and unstandardized beta's were reported. Results were considered significant when the upper and lower bound of the bootstrap 95% CIs did not contain zero.

## 4. Results

### 4.1. Analytical sample

There were complete baseline data on depressive symptoms available for 2268 people (1261 from cohort 1 and 2 and 1007 from cohort 3), and 1684 people had complete CES-D data on the follow-up measurement as well. Of those 1684 people, 1302 people had data on the ‘LASA Nutrition and Food-related Behaviour ancillary study’. People who did not fill out the questionnaire of the ‘LASA Nutrition and Food-related Behaviour ancillary study’ themselves ( $n = 103$ ), had missing values on the MEBS ( $n = 60$ ), missing values on the questions on antidepressant use ( $n = 46$ ), or missing values on any of the confounding variables ( $n = 70$ ), were excluded. People with baseline antidepressant use ( $n = 65$ ) and antidepressant use at follow-up ( $n = 12$ ), were additionally excluded, which resulted in an analytical sample of 946. Comparison of included ( $n = 946$ ) and excluded people ( $n = 356$ ) showed that excluded people were older ( $p < 0.001$ ), lower educated ( $p = 0.02$ ) and had more depressive symptoms ( $p < 0.001$ ) at baseline. The mean change in depressive symptoms of those 946 participants was 0.22, and the changes ranged from  $-31.0$  to  $23.0$ . In the mediation analyses, people with missing values on one or more of the psychological eating styles were additionally excluded ( $n = 4$ ). The characteristics of the sample are shown in Table 1.

### 4.2. Mindful eating and change in depressive symptoms

Results of the multiple linear regression analyses of the mindful eating domains on change in depressive symptoms are shown in Table 2. Higher scores on Focused Eating and Eating with Awareness

**Table 1**

Baseline characteristics of the study sample of Dutch people aged 55 years and older from the Longitudinal Aging Study Amsterdam (n = 946).

	mean [SD] or % (n)
Age (years)	66.6 [7.5]
Sex (% female)	50.7 (480)
Education (%)	
Low	11.2 (106)
Medium	57.2 (541)
High	31.6 (299)
Physical activity, minutes per day	160.1 [107.2]
Alcohol use, glasses per week	10.2 [10.4]
Smoking (%)	
Never	27.9 (264)
Former	61.4 (581)
Current	10.7 (101)
Body mass index (kg/m <sup>2</sup> )	26.9 [4.2]
Depressive symptoms, CES-D score <sup>a</sup>	5.0 [2.00–9.00]
Mindful eating, MEBS scores	
Focused Eating	20.0 [3.3]
Eating in response to Hunger and Satiety Cues	15.4 [5.2]
Eating with Awareness	13.0 [2.1]
Eating without Distraction	15.5 [2.7]
Psychological eating styles, DEBQ scores <sup>b</sup>	
Emotional eating	1.9 [0.8]
External eating	2.4 [0.5]
Restrained eating	2.7 [0.8]

Notes. SD = standard deviation; CES-D = Center for Epidemiologic Studies Depression Scale; MEBS = Mindful Eating Behavior Scale.

<sup>a</sup> The median score and interquartile range of depressive symptoms are presented because of a skewed distribution.

<sup>b</sup> n = 942 due to missing values.

**Table 2**

Adjusted associations of four mindful eating domains with 3-year change in depressive symptoms at follow-up in a sample of Dutch people aged 55 years and older from the Longitudinal Aging Study Amsterdam (n = 946)<sup>a</sup>.

	B	Lower BCa bootstrap 95% CI	Upper BCa bootstrap 95% CI
Focused Eating			
Model 1	−0.18*	−0.27	−0.09
Model 2	−0.13*	−0.23	−0.04
Eating in response to Hunger and Satiety Cues			
Model 1	0.01	−0.04	0.07
Model 2	0.03	−0.02	0.09
Eating with Awareness			
Model 1	−0.23*	−0.37	−0.08
Model 2	−0.24*	−0.39	−0.10
Eating without Distraction			
Model 1	−0.10	−0.22	0.02
Model 2	−0.14*	−0.26	−0.03

Notes. Depressive symptoms = Center for Epidemiologic Studies Depression Scale continuous score; B = unstandardized regression coefficients; BCa = bias-corrected and accelerated; CI = confidence interval. Bootstrap sample size = 5000.

Model 1: adjusted for baseline depressive symptoms; Model 2: additionally adjusted for baseline sex, age, educational level, alcohol consumption, smoking status, physical activity level, body mass index.

\*p < 0.05.

<sup>a</sup> Exclusion of people with antidepressant use at baseline and/or at follow-up.

were associated with lower depressive symptoms at follow-up after adjustment for depressive symptoms (model 1: Focused Eating: B = −0.18, 95% BC CI [−0.27; −0.09]; Eating with Awareness: B = −0.23, 95% BC CI [−0.37; −0.08]) and after additional adjustment for confounding variables at baseline (model 2: Focused Eating: B = −0.13, 95% BC CI [−0.23; −0.04]; Eating with Awareness: B = −0.24, 95% BC CI [−0.39; −0.10]). For every one unit increase in Focused Eating at baseline, a decrease in depression symptoms of 0.13

**Table 3**

Total and specific indirect effects from multiple mediation analyses of psychological eating styles (emotional, external and restrained eating) in the associations of four mindful eating domains with 3-year change in depressive symptoms in a sample of participants aged 55 years and older from the Longitudinal Aging Study Amsterdam (n = 942).

	B	Lower BC bootstrap 95% CI	Upper BC bootstrap 95% CI
Focused Eating			
Total	0.006	−0.014	0.029
Emotional eating	−0.002	−0.013	0.002
External eating	0.006	−0.001	0.023
Restrained eating	0.002	−0.013	0.018
Eating in response to Hunger and Satiety Cues			
Total	0.007	−0.001	0.017
Emotional eating	0.001	−0.001	0.017
External eating	<b>0.006</b>	0.0001	0.008
Restrained eating	−0.001	−0.006	0.004
Eating with Awareness			
Total	−0.047	−0.098	0.003
Emotional eating	−0.007	−0.063	0.045
External eating	<b>−0.040</b>	−0.084	−0.005
Restrained eating	0.0001	−0.005	0.007
Eating without Distraction			
Total	<b>−0.048</b>	−0.091	−0.011
Emotional eating	−0.011	−0.051	0.025
External eating	<b>−0.038</b>	−0.078	−0.004
Restrained eating	0.001	−0.010	0.014

Notes: Depressive symptoms = Center for Epidemiologic Studies Depression Scale continuous score; B = unstandardized regression coefficients; BC = bias-corrected; CI = confidence interval. Bootstrap sample size = 5000.

Analyses are adjusted for baseline depressive symptoms, sex, age, educational level, alcohol consumption, smoking status, physical activity level, body mass index.

Bold values indicate statistically significant results.

points was seen in the fully adjusted model and for every one unit increase in Eating with Awareness at baseline, a decrease in depression symptoms of 0.23 points was seen.

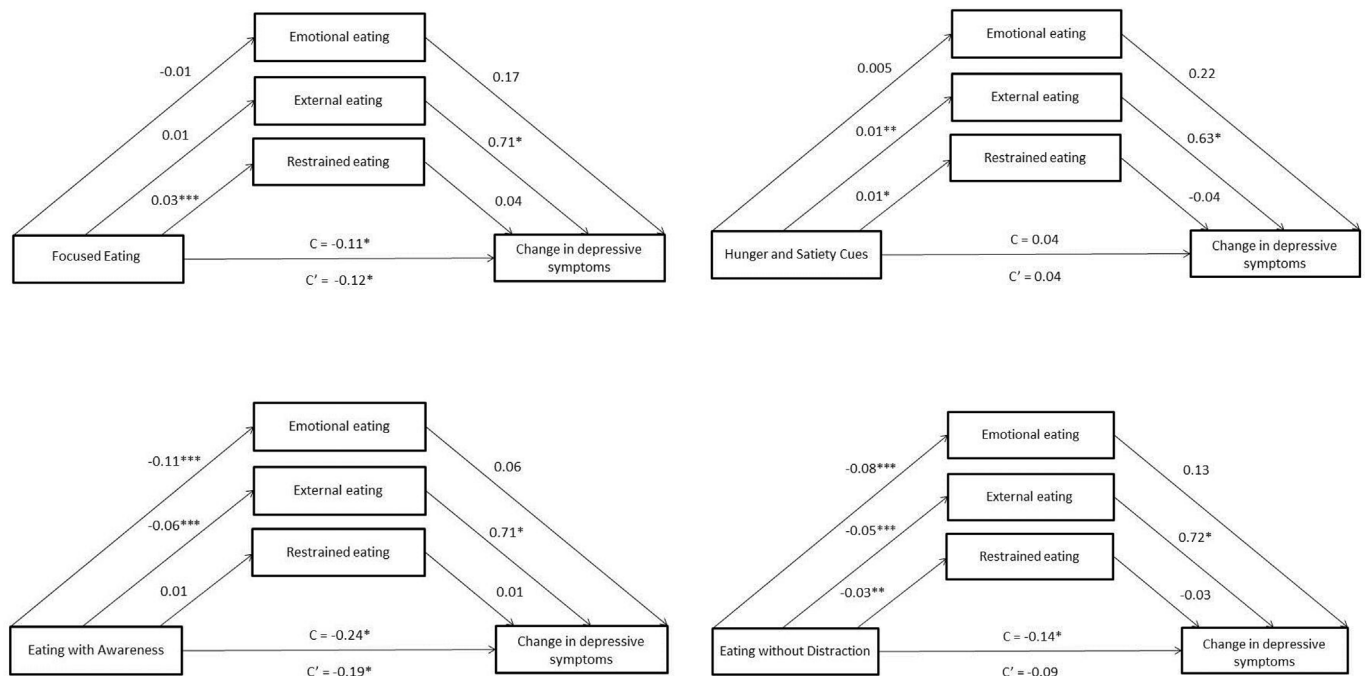
Eating without Distraction was not associated with depressive symptoms after adjustment for baseline depressive symptoms (model 1: B = −0.10, 95% BC CI [−0.22; 0.02]), but higher scores were associated with lower depressive symptoms when additionally adjusting for confounding variables (model 2: B = −0.14, 95% BC CI [−0.26; −0.03]). For every one unit increase in Eating without Distraction at baseline, a decrease in depression symptoms of 0.14 points was seen in the fully adjusted model.

The domain Eating in response to Hunger and Satiety Cues was not significantly associated with depressive symptoms at follow-up in any of the models (model 1: B = 0.01, 95% BC CI [−0.04; 0.07]; model 2: B = 0.03, 95% BC CI [−0.02; 0.09]).

#### 4.3. Mediation analyses of psychological eating styles

The total and specific indirect effects of the multiple mediation analyses of the psychological eating styles in the associations of the mindful eating domains with depressive symptoms are shown in Table 3. For the domain Focused Eating no mediation by the eating styles was found (e.g. total mediation: B = 0.006, 95% BC CI [−0.014; 0.029]). For the domain Eating without Distraction both total mediation and specific mediation by external eating was found (indirect effect total mediation: B = −0.048, 95% BC CI [−0.091; −0.011]; indirect effect mediation by external eating: B = −0.038, 95% BC CI [−0.078; −0.004]). For the domains Eating in response to Hunger and Satiety Cues and Eating with Awareness only specific mediation by external eating was found: B = 0.006, 95% BC CI [0.0001; 0.008]. In Fig. 1 the coefficients of the various paths of the multiple mediation models are shown; e.g. for every one unit increase in Eating with Awareness, a





**Fig. 1.** Multiple mediation models of the associations between four mindful eating domains and 3-year change in depressive symptoms via the psychological eating styles emotional, external and restrained eating in a sample of participants from the Longitudinal Aging Study Amsterdam ( $n = 942$ ). Unstandardized regression coefficients from a bootstrap procedure with 5000 samples are provided along the paths. Analyses are adjusted for baseline depressive symptoms, sex, age, educational level, alcohol consumption, smoking status, physical activity level, body mass index.

Notes. C = total effect; C' = direct effect; \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

decrease in external eating of 0.06 points was seen, and for every unit decrease in external eating, when controlling for Focused Eating, a decrease of 0.71 points in depressive symptoms was seen.

#### 4.4. Post-hoc analysis: serial mediation

Emotional eating might be causally related to external eating, because emotional eaters might shift their attention away from their negative affect by narrowing it to the immediate food environment; the escape-of-self-awareness-theory (Heatherton & Baumeister, 1991). Different electrophysiological studies indeed showed that emotional eaters showed a higher attentional bias to food cues than healthy-eating participants (review by Wolz, Fagundo, Treasure, & Fernández-Aranda, 2015; Wu et al., 2018). In Fig. 1 it is shown that Eating with Awareness and Eating without Distraction were associated with emotional eating, but that emotional eating was not associated with change in depressive symptoms. Earlier studies however reported an association between emotional eating and depression (e.g. Ouwens et al., 2009; Paans et al., 2018; Paans et al., 2018). This led us to the post-hoc hypothesis that emotional eating may be associated to change in depressive symptoms through external eating (serial mediation); such that emotional eating influences external eating, which in turn influences change in depressive symptoms.

Serial mediation of emotional and external eating in the associations of Eating with Awareness and Eating without Distraction with depressive symptoms was tested using the Process macro of Hayes (Hayes, 2013). Bootstrapping with 5000 samples was used and unstandardized beta's were reported. Results were considered significant when the upper and lower bound of the bootstrap 95% CIs did not contain zero.

For Eating with Awareness and Eating without Distraction it was found that both the model with external eating as mediator (indirect effect Eating with Awareness:  $B = -0.02$ , 95% BC CI [-0.05; -0.002]; indirect effect Eating without Distraction:  $B = -0.03$ , 95% BC CI [-0.05; -0.004]), and the model with serial mediation of emotional and external eating (indirect effect Eating with Awareness:  $B = -0.02$ ,

95% BC CI [-0.04; -0.002]; indirect effect Eating without Distraction:  $B = -0.01$ , 95% BC CI [-0.03; -0.002]) were significant. The mediation models with emotional and external eating as mediators and restrained eating as a covariate explained 40% of the variance in depressive symptoms for both mindful eating domains ( $R^2$  of the total effect models are 0.40 for both mindful eating domains). In Fig. 2 the coefficients of the various paths of the serial mediation models are shown.

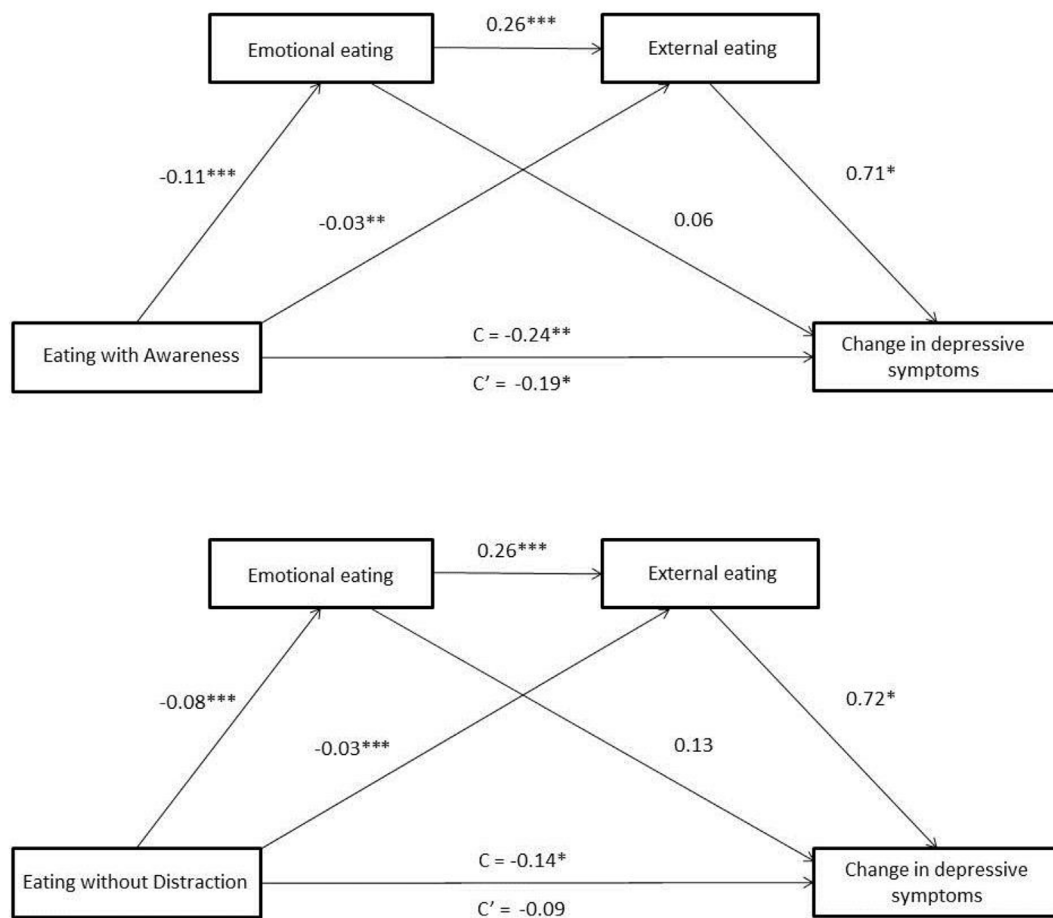
## 5. Discussion

This is the first study to investigate 1) associations of attentive mindful eating with change in depressive symptoms and 2) eating styles as possible mediators of these associations.

### 5.1. Mindful eating and change in depressive symptoms

Regarding the first aim, higher baseline scores on three of the four mindful eating domains, namely Focused Eating, Eating with Awareness, and Eating without Distraction, were significantly associated with a decrease in depressive symptoms during follow-up. These findings are in line with the findings of our earlier cross-sectional study (Winkens, van Strien, Brouwer, et al., 2018), in which the domains Focused Eating, Eating with Awareness, and Eating without Distraction were also inversely associated with depressive symptoms in three European countries. The domain Eating in response to Hunger and Satiety Cues was in the current study not significantly associated with depressive symptoms at follow-up, whereas in our earlier cross-sectional study positive associations were found (Winkens, van Strien, Brouwer, et al., 2018).

A possible explanation for the associations between higher Focused Eating, Eating with Awareness, and Eating without Distraction with lower depressive symptoms could be a direct effect of paying attention and having interest, which was also associated with higher quality of experiences (Brown & Ryan, 2003; Shapiro, Oman, Thoresen, Plante, &



**Fig. 2.** Serial multiple mediation of the associations between the mindful eating domains Eating with Awareness and Eating without Distraction and 3-year change in depressive symptoms via the psychological eating styles emotional and external eating in a sample of participants from the Longitudinal Aging Study Amsterdam ( $n = 942$ ). Unstandardized regression coefficients from a bootstrap procedure with 5000 samples are provided along the paths. Analyses are adjusted for baseline depressive symptoms, sex, age, educational level, alcohol consumption, smoking status, physical activity level, body mass index, restrained eating.

Notes. C = total effect; C' = direct effect; \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

Flinders, 2008), positive mood (Meier, Noll, & Molokwu, 2017), and higher enjoyment of previously disliked or avoided foods (Hong, Lishner, & Han, 2014). This study adds to the evidence that mindful eating is associated with depressive symptoms, also when looking at 3-year changes in depressive symptoms. A possible explanation for the non-significant association between Eating in response to Hunger and Satiety Cues and change in depressive symptoms may be the changes in hunger, satiety and appetite that occur in older adults (Elsner, 2002). Interoceptive sensitivity, the ability to sense bodily cues, which is associated with Eating in response to Hunger and Satiety Cues (Herbert, Blechert, Hautzinger, Matthias, & Herbert, 2013), also declines with age (Khalsa, Rudrauf, & Tranel, 2009).

## 5.2. Mediation by psychological eating styles

Regarding the second aim, to investigate mediation by the eating styles, for the domain Eating without Distraction both total mediation and specific mediation by external eating was found. For the domains Eating in response to Hunger and Satiety Cues and Eating with Awareness specific mediation by external eating was found. There was no specific mediation by emotional and restrained eating for any of the domains. Post-hoc analyses showed serial mediation by emotional and external eating in the associations of Eating with Awareness and Eating without Distraction with depressive symptoms as well. For the final domain, Focused Eating, there was no mediation by the eating styles.

## 5.3. External eating as mediator

External eating was a mediator in the associations with three mindful eating domains and depressive symptoms. One study also found that especially external eating changed as a result of a mindfulness intervention in obese women (Daubenmier et al., 2011). For both the domains Eating with Awareness and Eating without Distraction higher scores were associated with less external eating and fewer depressive symptoms. This is in concordance with earlier studies in which mindfulness-based interventions led to lower frequency of external eating (O'Reilly et al., 2014). In contrast, higher scores on the domain Eating in response to Hunger and Satiety Cues were associated with *higher* external eating and more depressive symptoms in the current study. In Winkens et al. (2018) we also found that Eating in response to Hunger and Satiety Cues was positively associated with depressive symptoms. This might be due to the changes in hunger, satiety, and appetite that occur due to the aging process (Elsner, 2002). We should further note that the lower limit of the confidence interval of the indirect effect of external eating for the domain Eating in response to Hunger and Satiety Cues was very close to zero ( $B = 0.0001$ ), so these findings should be replicated, especially also in younger samples.

## 5.4. Restrained eating as mediator

Restrained eating did not mediate any of the associations (specific mediation). Theoretically, mindful eating was expected to be related to

lower levels of restrained eating, by increasing the reliance on hunger and satiety cues. However, previous research showed an increase in dietary restraint instead of a decrease (Alberts et al., 2012; Dalen et al., 2010). A possible explanation for these findings might be that there are two types of restrained eaters: those with a high tendency towards overeating and those with a low tendency towards overeating (respectively high and low disinhibition or unsuccessful and successful dieters; Ouwens, van Strien, & van der Staak, 2003; Van Strien, 1997; Stroebe et al., 2013). It is possible that mindful eating only influences one type of restrained eaters, or that it decreases dietary restraint in people with a high level of disinhibition (unsuccessful dieters), but increases dietary restraint in people with a low level of disinhibition (successful dieters). This could possibly explain the non-significant indirect effects in this study, and also the mixed findings of earlier studies into restrained eating and depression. Further research into mindful eating, depression and these different types of restrained eaters is needed.

### 5.5. Serial mediation of external eating preceded by emotional eating

In post-hoc analyses there was serial mediation of external eating preceded by emotional eating for two mindful eating domains. Because emotional eaters show a heightened attentional bias to food cues (Wolz et al., 2015; Wu et al., 2018), it is important to know that a decrease in emotional eating by an increase in mindful eating could be beneficial for mental health as well (through a decrease in external eating). Future studies should be aware of this possible serial mediation.

### 5.6. Focused Eating

For the mindful eating domain Focused eating there was no mediation by the psychological eating styles. Other underlying mechanisms could be involved in this association. Focused Eating was only associated with restrained eating ( $B = 0.03$ , 95% BC CI [0.02; 0.05]), in that higher scores on Focused eating were associated with higher scores on restrained eating. Focused Eating was not associated with emotional and external eating in this study. An explanation might be that paying attention to food while eating is different from paying attention to (attractive) food cues in general or to eating when experiencing negative emotions. Another study also found that the 'observing' component of mindfulness was not uniquely associated with eating pathology (Lavender, Gratz, & Tull, 2011).

### 5.7. Strengths and limitations

A strength of this study is that data from two different time points were used, which allowed an analysis of change in depressive symptoms over time. In addition, multiple mediation models were conducted, which reduces the likelihood of parameter bias due to omitted variables (Preacher & Hayes, 2008). In post-hoc analyses, serial mediation was conducted, which made it possible to gain insight into different causal paths. Other strengths are that compared to previous studies, a large representative sample of older adults was used and that the scale to measure mindful eating was able to measure mindful eating distinguishable from the eating styles (Winkens, van Strien, Barrada, et al., 2018).

One limitation is that mindful eating and the psychological eating styles were measured at the same time point, whereas in mediation analyses desirably the temporal order of all of the variables is tested. Another limitation regarding the temporality is that mindful eating and the psychological eating styles were measured in between the baseline and follow-up measure of depressive symptoms. Although the causal order of the mindful eating domains and the psychological eating styles therefore cannot be established, mindful eating is hypothesized to precede the eating styles in time, because one earlier study found that mindfulness predicted eating styles in time and not the other way

around (Sala & Levinson, 2017). The current mediation analyses are only exploratory due to the limitations of the study design. They are useful as a template for analyses of causality and temporal ordering. Further research is needed to test the associations of mindful eating with change in the eating styles over time, and ultimately change in depressive symptoms.

Another limitation is that results of this study might not be generalizable to younger age samples, especially with regard to the mindful eating domain 'Eating in response to Hunger and Satiety Cues'. Because of physiological and psychological alternations when aging, hunger, satiety and appetite might change (Elsner, 2002; Morley, 2012, 2013). The ability to sense bodily cues also declines with age (Khalsa, Rudrauf, & Tranel, 2009). Results with this particular mindful eating domain might thus not be representative of the general population and should be replicated in different age groups.

Another limitation is that no earlier episodes of depression were taken into account; therefore we cannot rule out the possibility that earlier depressive episodes may have influenced the associations under study. Because participants with higher baseline values of depression were lost to follow-up more often than participants with lower baseline values of depression (7.7% of participants with CESD < 16 at baseline were lost to follow-up versus 11.7% of participants with CESD  $\geq$  16 at baseline), this sample might consist of a relatively healthy sample. However, the percentage of participants with a clinically relevant level of depressive symptoms (CESD  $\geq$  16) is the same at both time points: 10.2% versus 10.3%.

General mindfulness was not measured in this study, making it impossible to assess whether mindful eating is related to depression above possible relations with general mindfulness. Previous research showed that mindful eating interventions were more effective in changing obesity-related eating behaviours than general mindfulness interventions (O'Reilly et al., 2014), which suggests that mindful eating is a different construct with potentially different effects. Further research into the unique effects of mindful eating is needed.

## 6. Conclusion

The results of this study suggest that higher baseline scores on the attentive mindful eating domains Focused Eating, Eating with Awareness, and Eating without Distraction are related to 3-year decrease in depressive symptoms. The psychological eating style external eating is a mediator in the associations of Eating in response to Hunger and Satiety Cues, Eating with Awareness, and Eating without Distraction with change in depressive symptoms. This could imply that increasing mindful eating might make people less susceptible to attractive food cues. Eating with Awareness and Eating without Distraction are also related to change in depressive symptoms through external eating preceded by emotional eating (serial mediation). Future research should investigate whether increasing mindful eating and reducing emotional eating could prevent depression through reducing external eating.

### Conflicts of interest

Tatjana van Strien has a copyright and royalty interest in the Dutch Eating Behaviour Questionnaire (DEBQ) and manual. The other authors declare no conflict of interest.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2018.11.009>.

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